All entangled states display some hidden nonlocality

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A well-known manifestation of quantum entanglement is that it may lead to correlations that are inexplicable within the framework of a locally causal theory – a fact that is demonstrated by the quantum violation of Bell inequalities. The precise relationship between quantum entanglement and the violation of Bell inequalities is, however, not well understood. While it is known that entanglement is necessary for such a violation, it is not clear whether all entangled states violate a Bell inequality, even in the scenario where one allows joint operations on multiple copies of the state and local filtering operations before the Bell experiment. In this talk we show that all entangled states, or more precisely, all not-fully-separable states of arbitrary Hilbert space dimension and arbitrary number of parties, violate a Bell inequality when combined with another state which on its own cannot violate the same Bell inequality. This result shows that quantum entanglement and quantum nonlocality are in some sense equivalent, thus giving an affirmative answer to the aforementioned open question. It follows from our result that two entangled states that are apparently useless in demonstrating quantum nonlocality via a specific Bell inequality can be combined to give a Bell violation of the same inequality. Explicit examples of such activation phenomenon are provided.